8. Manipulation of Terrestrial Resources (include relevant quantities - sq. ft., cu. yard, etc.)

No changes to terrestrial resources are proposed.

9. Manipulation of Aquatic Resources (include relevant quantities - cfs, acre feet, MGD, etc.)

The natural pattern of water levels in flow-through lakes is associated with high water levels in April, May, and June due to the melting snowpack and water inflow from storm events. This natural pattern of water levels is much different when compared to the pattern of water elevations on the Chain of Lakes due to the current operation of the Rest Lake Dam (Figure 30). Low water levels on the Chain occur from late fall through the following summer (generally until late May or early June) because of the 3.5 foot winter drawdown and timing of the spring refill. In low precipitation years, the Chain does not reach the summer 8' 6" maximum water level because of the extent of the fall drawdown, the timing of the Chain refill, naturally low inflows, and pumping to irrigate cranberry beds.

Downstream of the dam, from spring through fall, the natural pattern of flows of the Manitowish River have mostly been eliminated and reversed due to the current operation of the dam. A natural flow pattern includes a high spring flow "flood pulse" followed by flows that gradually decrease through the summer, with the lowest flow occurring in late summer and early fall. The natural flow pattern for the Manitowish River was determined by USGS (figure 30). With current dam operations, water is typically held back to fill the Chain from April until June and during this time the minimum flows passed downstream create drought conditions on the river on an annual basis. During low precipitation years, these artificially low river flows may continue until fall while the chain is being refilled. The highest flows of the year are released downstream in late fall during the drawdown of the Chain of Lakes.

The Department is proposing to issue a new operating order that would result in water levels and flows upstream and downstream of the dam that closely match the natural pattern of levels and flows of northern Wisconsin flow-through lakes and rivers. To accomplish this, the extent and timing of the winter drawdown would need to be eliminated or greatly reduced, a more natural flow pattern would be passed downstream of the dam, and ramping rates would be specified for both Chain water levels and downstream flows to avoid quickly fluctuating water levels. On the Chain, this proposal would positively affect the hydrology of the 934 acres of wetlands mapped adjacent to the lakes, the shallow water areas identified on the lake maps (appendix III), and the lake shorelines. Downstream, the proposal would affect the instream river channel habitat, the 1500+ acres of riparian wetlands located adjacent to the river channel, and the banks of the river.

10. Buildings, Treatment Units, Roads and Other Structures (include size of facilities, road miles, etc.)

In order to restore a natural pattern of water levels and flows, water elevations on the Chain would need to be kept higher while ice is present. To avoid and minimize possible ice damage to structures, it is anticipated that more piers would need to be taken out of the water in the fall. For structures that cannot be moved, it is likely that aeration systems, physical ice deflectors, or other methods would need to be installed to protect against possible ice damage. These techniques to protect structures are used on the majority of lakes in Wisconsin, including natural lakes and impoundments.

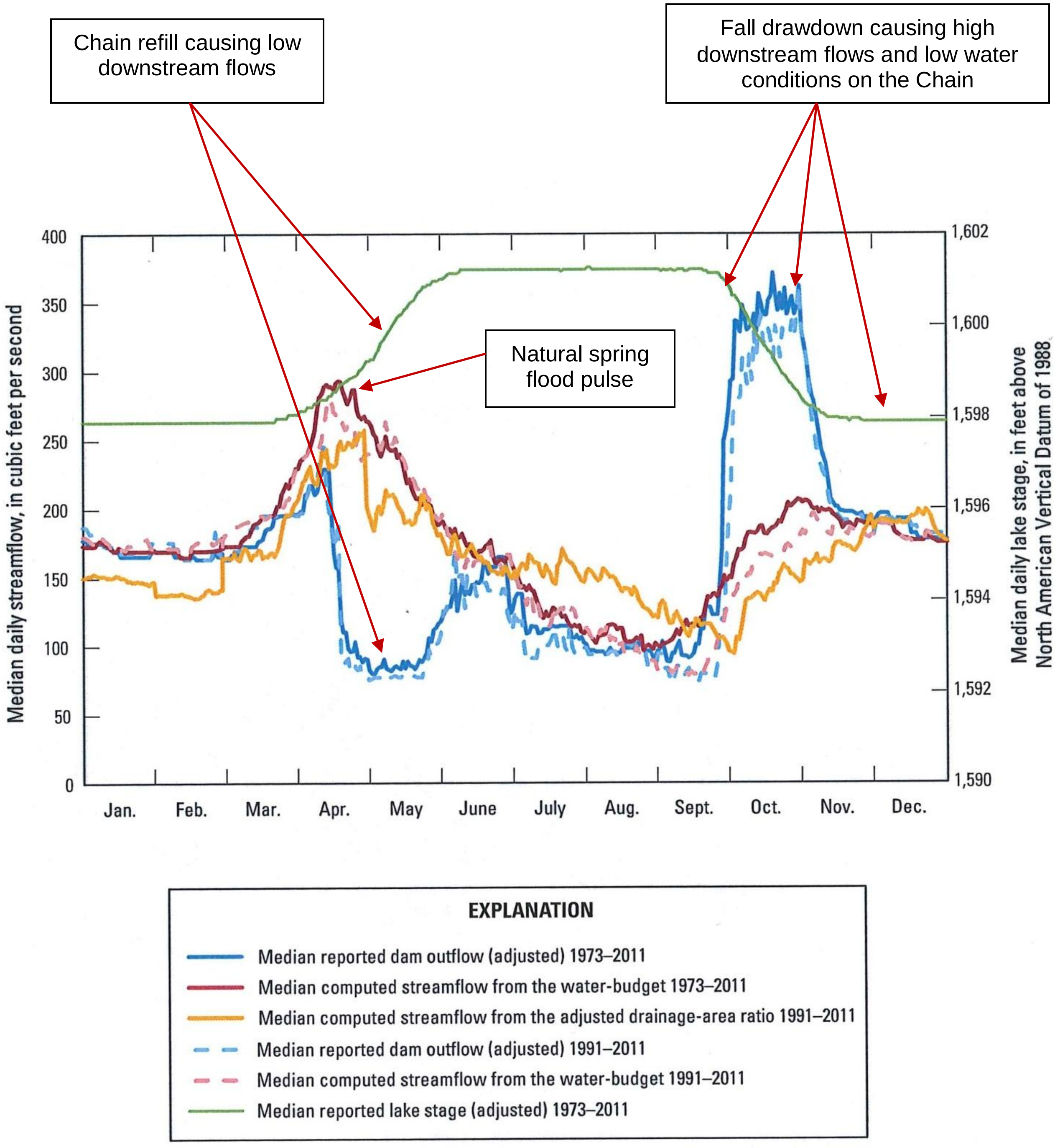
11. Emissions and Discharges (include relevant characteristics and quantities)

No changes to emissions and discharges proposed.

12. Other Changes

No other changes are proposed.

Figure 30. Natural Pattern of Manitowish River Flows in Relation to the Discharge at the Rest Lake Dam and Filling and Drawdown of the Chain of Lakes (from USGS report)**.**



14. Describe the impacts of no action and of alternatives that would decrease or eliminate adverse environmental effects.

The following alternatives were evaluated in this environmental assessment.

- **Alternative I.** Current operations (page 51)
- **Alternative II.** The 1939 operating order (page 52)
- **Alternative III.** Public Interest River Flow and Lake Stage (page 67)
- **Alternative IV.** Passing inflows (page 68)

Alternative I. Current Operation

The current operation alternative means that the current management of water levels and flows would continue (Table 9). The current operation does not follow some of the provisions of the 1939 operating order. For this alternative, the Department would need to authorize a new operating order that follows the current management of water levels and flows.

Table 9: Summary of the Current Operation of the Rest Lake Dam

Dates	Headwater Levels	Flows
Winter: November 8 to 75% ice off Rest Lake (~ April 20)	5' 0"	Run of River (1)
Spring: ~April 20 to July 1 (2)	Chain refill from 5'0" to 8'6"	40 cfs of more
Summer: July 1 to September 28	8'4"-8'6"	40 cfs or more (3)
Fall: September 28 to November 8 (4)	5'0" (5)	40 cfs of more

(1) Outflow equals inflow.

(2) Average refill (full pool) date is June 6th. The total number of days to fill the Chain has ranged from 11 to 108 days. There has not been enough precipitation to refill the reservoir five times (1988, 2005, 2006, 2007, and 2009). During the spring refill period, the flows on the river are reduced to the Q7-10, which is currently estimated to be 40 cfs, has ranged from 30 and 50 cfs in the past.

(3) To maintain summer pool elevations between 8'4" and 8'6", flows have been reduced to 40 cfs or lower.

(4) In recent years, drawdown has started on ~ September 28 instead of September 1.

(5) At no time shall the Chain be lowered at a rate exceeding 2 inches per day, or at no time shall the Chain be lowered after ice forms.

Alternative II. 1939 Operating Order

Records are available for the daily discharge over the dam and Rest Lake water levels from 1955-1961 and 1973 to current. These records show that certain provisions of the 1939 operating order are not currently being followed. The provisions of the 1939 order and the current minimum $Q_{7\text{-}10}$ flow are summarized in table 10.

Table 10. Summary of the 1939 Operating Order

Dates	Headwater Levels	Minimum Flow
November 1 to Spring thaw (initial runoff event, ~ 3rd week of March).	Minimum of 5’0”	Run of River (outflow equals inflow)
Spring thaw to April 15 (~ *ice out on Chain*)	Minimum of 7’3”	$Q_{7\text{-}10}$ = 40 cfs
April 15 to July 1	7’3”- 8’6”	$Q_{7\text{-}10}$ = 40 cfs
July 1 to September 1	No lower than 7’3”- 8’6”	$Q_{7\text{-}10}$ = 40 cfs
September 1 to November 1	No lower than 5’0”	$Q_{7\text{-}10}$ = 40 cfs

With current operations, spring refill does not begin until ice is 75% off of Rest Lake to avoid potential ice damage to permanent piers and boat houses. On average, refill begins on April 20th which is often after most of the high spring runoff events have passed through the dam. High spring runoff flows are not captured to bring the Chain to 7’ 3” by April 15th as written in the 1939 order. Under current operations, during the summer months, reservoir storage is not used to augment low flows downstream and water levels are maintained in a narrow range between 8’ 4” and 8’ 6”, not between 7’3” and 8’6” as specified in the 1939 operating order. Currently, when water levels drop below 8’ 4”, flows over the dam are quickly reduced to minimum flows (40 cfs). In the fall, to accommodate navigation during community events such as Colorama, the reservoir is maintained at 8’ 6” until late September or early October. The 1939 order specifies that a drawdown to the target 5’ 0” winter level could begin September 1st.

Impacts Associated with Current Operations and the 1939 Operating Order

Aquatic Habitat on the Chain

Upstream of the dam, under both the current operations and the 1939 order, the 3.5 foot winter drawdown would continue to result in dewatering aquatic bed wetlands and shallow water habitat from the fall until the spring or early summer. In low precipitation years, low water in these areas would continue through the entire summer as occurred in 2007. The wetlands on natural flow through lake systems in northern Wisconsin do not experience the extent, timing, or duration of the low water levels that would occur with both of these alternatives. Both alternatives would continue to negatively impact the ability of wetlands and shallow water habitat to provide for the life history needs of the diverse community of mammals, waterfowl, loons, fish, herptiles (amphibians and reptiles), and aquatic insect life. The impacts of insufficient surface water in wetlands and shallow water areas are especially detrimental during the fall, winter, spring, and early summer. During fall, amphibians and reptiles move into these critical areas seeking out leaf debris and soft bottom sediments where they overwinter. With the timing of the fall drawdown, these habitats would be sought out before the water levels drop. After finding what would appear to be appropriate habitat, the animals enter a state of reduced metabolic activity and are unable to quickly relocate to appropriate habitat. As water levels drop, the amphibians and reptiles would be exposed to winter elements and most would not survive. Depending to the success of the early stages of refilling the Chain in spring, many of these shallow water areas would also not be available at the start of the growing season when aquatic habitat is needed for spawning, reproduction, and rearing. For example, depending on the timing and duration of the refill, increasing water levels may negatively affect the success of loon nesting. The month of May is a critical time period for nesting loons and would be associated with rising water levels with both alternatives. Once on the nest and incubating, depending on the nest location, some would likely encounter nest flooding with rising water levels during the refill period. The annual winter drawdown and associated water level fluctuations would also continue to be detrimental to the organisms that depend on habitat in the near shore shallow water zones, and to native plant communities trying to establish in these zones. Lower densities of aquatic plants and less organic matter build up in the near shore would continue which provide favorable conditions for walleye and perch populations. Since spawning occurs early in the spring while the Chain would be at or near the 5’0” water elevation, the drawdown associated with these alternatives would likely have only a small influence on populations.

Although both alternatives would continue to create annual low water conditions in aquatic habitat on the Chain, if the provisions and intent pertaining to the spring refill period of the 1939 operating order were followed, it would result in the capturing more of the high spring inflows to fill the Chain. This could reduce the time needed to fill the Chain and consequently reduce low water conditions in wetlands and shallow water areas during spring and early summer. The duration and timing of the spring refill would continue to be highly dependent on the extent of the snow pack and the timing of spring rainfall events. Although following the 1939 Order could reduce the duration of low water impacts compared to the current operation, the annual low water conditions caused by the drawdown would still be highly disruptive to wetland function and life history needs of a wide range of organisms that utilize these wetland areas.

The dewatering of the aquatic bed wetlands and shallow water areas on the Chain that would be associated with both current operations and the 1939 Order, along with additional descriptions of the associated environmental impacts, are shown on the following pages in Figures 31 and 32.

Figure 31. The picture above and below show the water level changes that occur in shallow aquatic bed wetlands on Island Lake at the 8' 6" (top picture) and 5' 9" (bottom picture) water level. The white stars identify the same area on each photo. The low water conditions in these areas has negative impacts on many wetland functional values including negative impacts to the diverse fish and wildlife species that need sufficient surface water in order to utilize these areas.

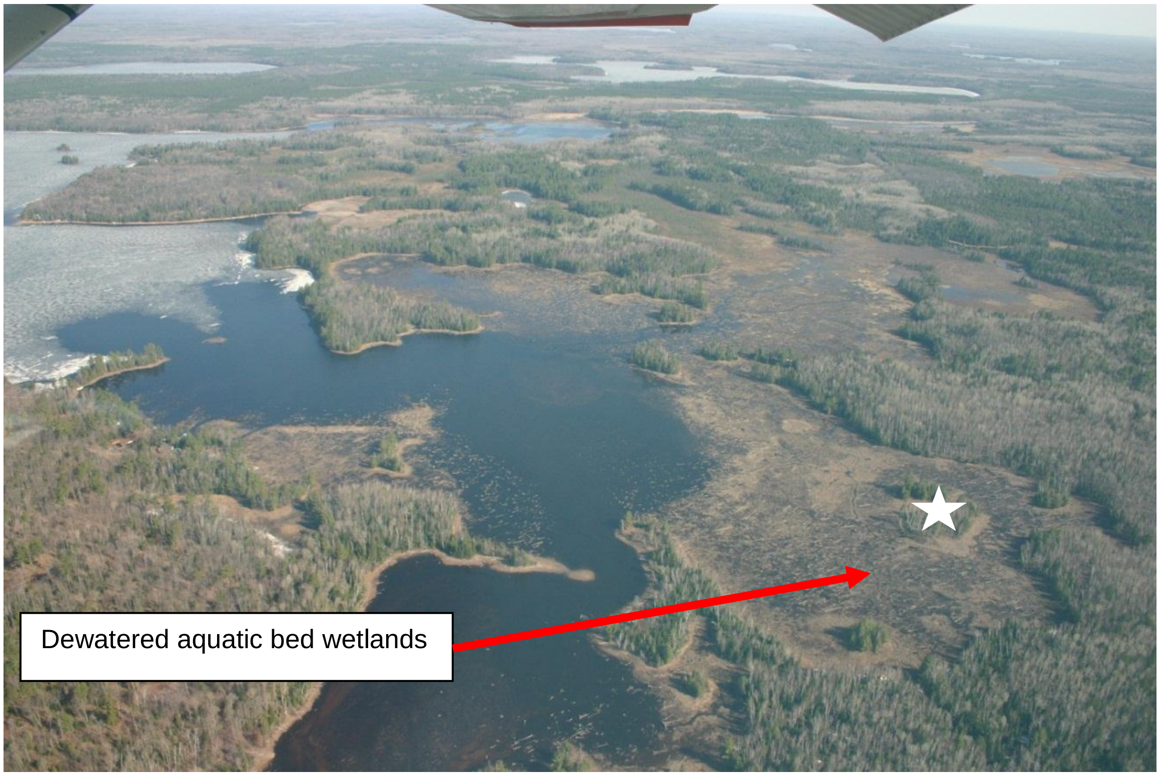


Figure 32. The picture above and below show an "on the ground" view of the water level changes that occur in shallow aquatic bed wetlands on Clear Lake at the 8' 3" and 6' 2" water level. The lack of water and low water conditions in these wetlands in the spring, throughout the summer, and to overwinter, negatively impacts the diverse fish and wildlife species that can only utilize this type of habitat when it is sufficiently flooded. The white star on each photo serves as a reference point for location identification.

Aquatic Habitat Downstream of the Dam

With a 3.5 foot winter drawdown and a narrow Chain elevation operating range over the summer, both alternatives would cause a high occurrence of low water levels in the wet meadow and scrub/shrub wetlands, oxbows, backwater sloughs and rocky riffle areas during early spring. Based on USGS estimates, flows of 40 cfs in April and May represent flows that would naturally occur only very rarely on the river (less than 1% of the time). With both alternatives, in some years, drought river conditions would be carried through the entire summer growing season in order to fill and maintain the elevation of the Chain. Although these conditions would not be of the same duration from year to year, the unnatural low water levels and flow conditions would occur on a yearly basis. Even though drought is a natural phenomenon, the artificial manipulation of river flows mimicking these conditions on a yearly basis is not. This is considered to be highly disruptive to the river ecosystem. Following the 1939 order would somewhat reduce the duration and frequency of low flows on the river by starting to refill the Chain earlier, capturing the initial spring runoff, and utilizing a wider operating range in the summer to augment downstream flows.

The median reported outflows (Xcel discharge through the dam) shown in figure 30 depict the drought level flows that are currently discharged through the dam. On average, these flows generally occur from mid-April to June. The plant and animal life associated with river systems have adapted to, and are dependent on, natural flow patterns. In the 1,500+ acres of riparian wetlands, oxbows, and backwater sloughs, the river's spring flood pulse is the driving force which sustains all life history needs of the plants and organisms (aquatic and terrestrial) that depend on these areas. Both the current operation and the 1939 order would result in disrupting this flood pulse each spring. This is a critical time period for the species associated with the riparian wetland habitat of the river, and both alternatives would continue to negatively impact the species described earlier in the analysis that depend on these areas. Current research has demonstrated that reducing spring flows during the early and mid-growing season on rivers negatively affects riparian wetlands, aquatic habitat, and the associated fish and wildlife species (Richter and Thomas, 2007, Richter et. al. 2006). The high occurrence of low water conditions on the river has also likely resulted in changes to the riparian wetland community. It is likely that over time, the wetlands along the river changed from being dominated by meadow species (sedges, grasses, forbs) to having a much higher density of shrubs (such as tag alder and willow).

In the rocky riffle spawning section of the river, both the current operation and the 1939 order would often pass 40 cfs during the spring. This minimum flow would continue to limit the habitat available for a number of aquatic organisms and limit the spawning success of greater redhorse and lake sturgeon.

The water levels of the river would also continue to quickly fluctuate. Many of the backwater and oxbow areas become dewatered and disconnected from the main river channel within 24 to 48 hours. These quickly changing water levels would continue to results in fish stranding as well as have direct impacts to other organisms dependent on these habitats. Fish and wildlife that are able to move out of these areas in time are forced to relocate from what otherwise would be excellent habitat for feeding and reproduction. During the fall, high flows associated with the drawdown of the Chain quickly floods the downstream wetlands and would continue to impact the over wintering success of a number of mammals, reptiles, amphibians, insects, and other aquatic and semi-aquatic organisms.

Figures 33 through 36 on the following pages show the low water conditions that would occur in the riparian wetlands and the rocky riffle area and also provide additional descriptions of the impacts associated with alternatives that have a 3.5 foot winter drawdown of the Chain.

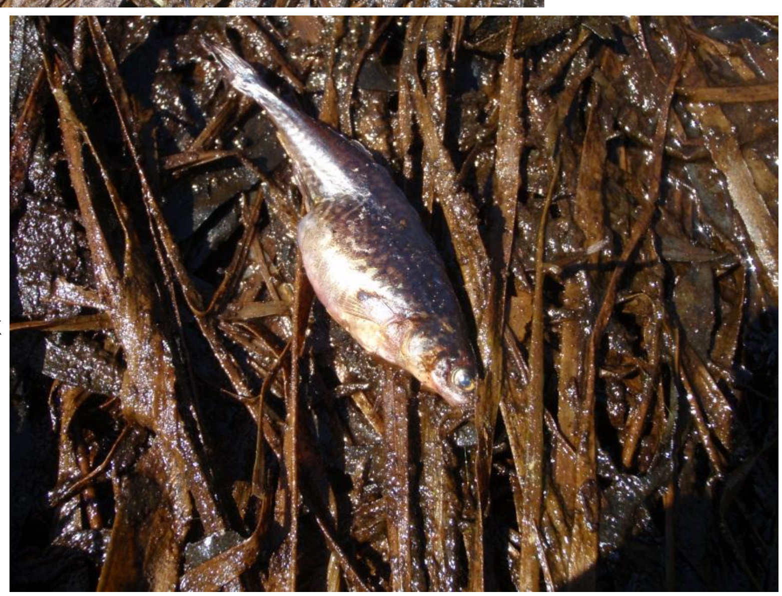
Figure 33. The aerial picture above shows the river and connected riparian habitat at 455 cfs. The picture below was taken at 40 cfs and shows the effect the Chain refill has on downstream resources. The natural flood-pulse of the river has been eliminated, riparian wetlands are left dry, and many of the oxbow and backwater areas are dewatered and/or become disconnected from the main river channel. It is important to note that at 200 cfs, the entire riparian wetland zone from tree line to tree line is completely inundated with water. The white stars serve as reference points for location identification. (455 and 40 cfs were Xcel reported flows).

Figure 34. The photos above and below show the “on the ground” conditions in the same river oxbow at high and low river flows. The above conditions are what is expected to typically occur during natural spring flows. When the dam is shut down to 40 cfs, these old stream channels quickly dewater, leaving conditions depicted in the photo below. Available aquatic habitat is lost, along with the functional value of the associated wetlands. Fish and other aquatic organism stranding has been observed and documented in these areas along with loss of spawning, feeding, and nursery areas for fish, waterfowl, and furbearers. The white stars serve as reference points for location identification.

Figure 35. Pictures of fish and other aquatic organism stranding in the wetlands along the Manitowish River after quickly changing river flows.

35a. Tadpoles

35b. Pumpkinseed



35c. Gravid brook stickleback

Figure 36. There are very limited areas of rocky riffle bottom habitat on the Manitowish River below the Rest Lake dam. The photos on this page were taken at high (240 cfs) and low (40 cfs) flows (Xcel reported flows). Portions of this rocky river bottom are dewatered or have very shallow water at the low flows that are passed each spring and early summer when a number of fish and wildlife species utilize this type of habitat.

Cultural Resources
Wild rice productivity is likely negatively impacted by rising water levels during the floating leaf stage in May and June. On the Chain, both current operations and the 1939 order would be associated with rising water levels in May and June in low precipitation years when it takes longer to refill the winter drawdown. It is likely that the 1939 order would decrease the frequency of rising water levels during this time since the spring refill would occur earlier and would allow the Chain to fill more quickly.

As described earlier, the annual winter drawdown associated with both alternatives would provide conditions favorable to walleye. These fluctuations, however, may also be associated with higher mercury content in walleye and other predatory fish. The 3.5 foot drawdown and refill could increase the amount of mercury that can enter into the food chain. According to a report prepared by the Great Lakes Indian Fish and Wildlife Commission (Groetsch, et. al. 2003), "*Dam operation regimes that result in fluctuating water levels in a reservoir likely cause water levels to change in back water bays and riparian wetlands. This water level change may result in increased production and (or) bioavailability of methylmercury (Snodgrass et al. 2000, Mucci et al. 1995, Grondin et al. 1995, Louchouarn et al. 1993)*". Access to the lakes to harvest walleye during their spring spawning period would be negatively affected by the winter drawdown. Lake access and navigation are described in more detail in the Social and Economic Environment section below.

As stated earlier, in the rocky riffle spawning section of the river, both the current operation and the 1939 order would often pass 40 cfs during the spring. This minimum flow would continue to limit the spawning success of lake sturgeon. Age estimates from captured lake sturgeon suggest that with current operations some level of natural reproduction has occurred within the system. The years of natural lake sturgeon reproduction correspond to high precipitation years when there was a quick refill and high flows were passed below the Dam during their spawning period. However, at this time, it is assumed that the level of natural reproduction is not sufficient to maintain a self-sustaining, naturally-reproducing population of this long lived species. Females do not reach sexual maturity until approximately 20 years old, while males will begin to spawn at 12 to 15 years old. Because of these factors, young lake sturgeon are periodically stocked in order to supplement natural reproduction. The Wisconsin DNR continues to study this lake sturgeon population, with the ultimate goal of a self-sustaining population of lake sturgeon, completely independent of stocking, becoming established in the Turtle Flambeau Flowage and the Manitowish River system. It is likely that the 1939 order would somewhat increase the years of successful reproduction since this alternative would be associated with refilling the Chain more quickly in the spring and higher downstream flows.

If any archaeological sites are currently affected by wave action at the 8' 6" water elevation, both the current operation and the 1939 order would continue to impact these resources. Wave action on the shoreline would not change under both alternatives because the 3.5 foot winter drawdown would likely result in lower aquatic plant densities in the near shore zone. Aquatic plants in this area are important components of lakes that help protect shorelines from erosion caused by wave action. The primary difference between these two alternatives is that the 1939 order would be associated with rising water levels in early spring and some years this would be expected to occur while there is still ice on the lakes. This would increase the potential for ice to act on shorelines. More detailed description of the potential for ice action on shorelines is described in the Social and Economic Environment section below.

Before implementation of any changes to the operation of the dam, close coordination between DNR staff and Department and Lac du Flambeau archaeological staff would be needed. If changes in operation would potentially cause erosion at an archaeological site, bank stabilization and shoreline protection techniques could be installed to prevent damage to these sites. Special techniques to protect archaeological sites have been developed for reservoirs. Wisconsin Valley Improvement Company, for example, has successfully installed shoreline and bank stabilization to protect archeological sites on Rice Reservoir in northern Wisconsin, 16 miles southeast of Rhinelander.

Social and Economic Environment
Aspects of the social and economic environment that would be impacted by the current operation of the dam and the 1939 order include the pumping of water for cranberry production, shoreline erosion, and navigation.

Cranberry producers have indicated that pumping is difficult when water levels are low on the Chain because of the shallow water depths and the increased amount of plant material and other debris that is sucked into the pumps. The 3.5 foot drawdown would continue to cause periodic low water conditions on the Chain. This would be especially apparent during low water years if low water levels from June through fall similar to what occurred in 2007. As described earlier, the 1939 order would be expected to have a reduced frequency of low water levels due to the earlier spring refill period. Therefore, the problems with diverting water for cranberry operations would be expected to occur less frequently with this alternative.

Many shoreline structures are located above the water line at the 5’ 0” water elevation. With current operations, piers and other structures on the Chain would not be damaged by ice action. The quickly changing flow and high flows downstream of the dam however, would continue to flood piers and cause shoreline erosion and slumping of river banks. By following the earlier refill period associated with the 1939 operating order, water levels would sometimes rise while there is still ice on the lakes. This would increase the potential for ice to act on structures and shorelines. Most of the lakes on the Manitowish Chain have a fetch of a mile or less and are considered low energy shorelines.

As described earlier, aquatic plants in the near shore environment are important components of lakes that help protect shorelines from wave action. The influence of wave action on the Chain shoreline would not change under either alternative since the 3.5 foot winter drawdown and lower aquatic plant densities in the Chain would remain the same.

Recreation would continue to be negatively impacted by continued current operations or the 1939 operating order due to the impacts of the associated low water conditions on navigation. Upstream of the dam, the usability of some of the boat ramps is negatively affected at low water levels which would make access to the lakes more difficult in fall during the drawdown and early spring and summer during the refill period. The 1939 order would reduce the duration of low water due to an earlier spring refill. Figures 37 to 41 show the water elevations and depths at the major boat launches on the Chain. The cement planks of many of these launches are exposed or near the water’s edge when the Chain is at the 5’ 0” water level. Although conditions to launch a boat at the 5’0” water level may not be as good as it is during the full pool 8’ 6” elevation, the launches at Rest, Clear, and Spider Lakes are considered usable given the relatively steep drop off along the shoreline and the stable sand lakebed substrate in these areas. The boat launches at Wild Rice and Island Lakes do become very difficult to use for trailered boats at the 5’ 0” water level because of the shallow water conditions and muckier lakebed substrate at these launches. At Wild Rice Lake, there is also a potential navigational obstruction during low water due to the raised lakebed and scour at this launch that has likely been caused by power-loading boats onto trailers.

Figure 37. Rest Lake Boat Launch Profile

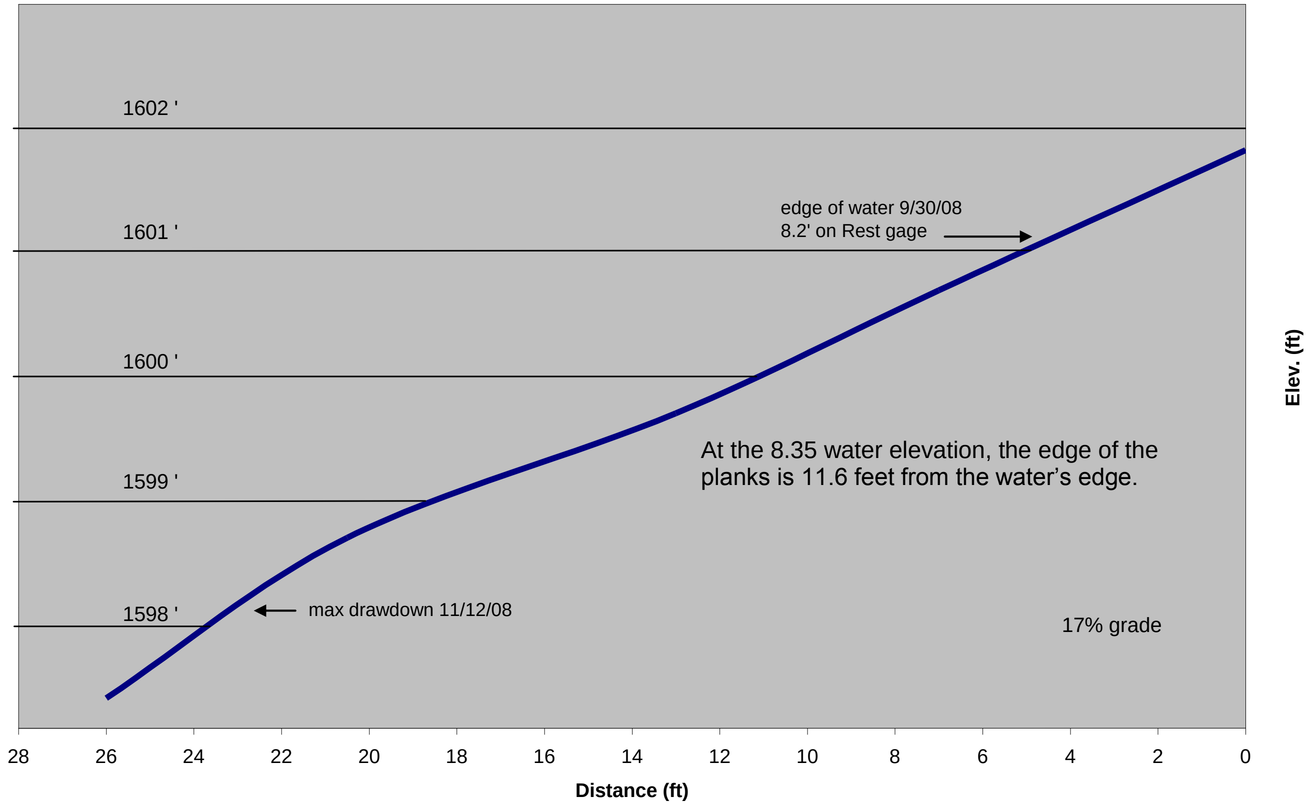


Figure 38. Clear Lake Boat Launch Profile

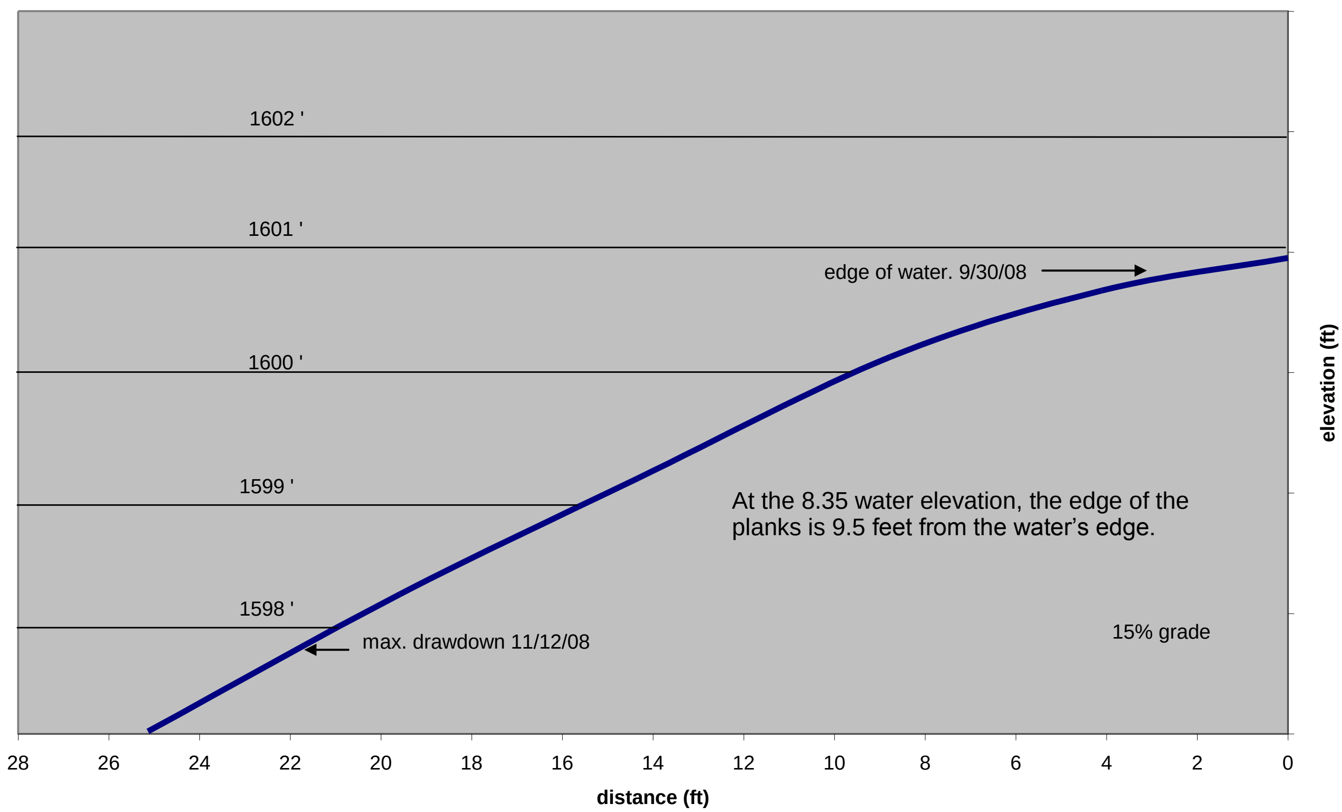


Figure 39. Spider Lake Boat Launch Profile

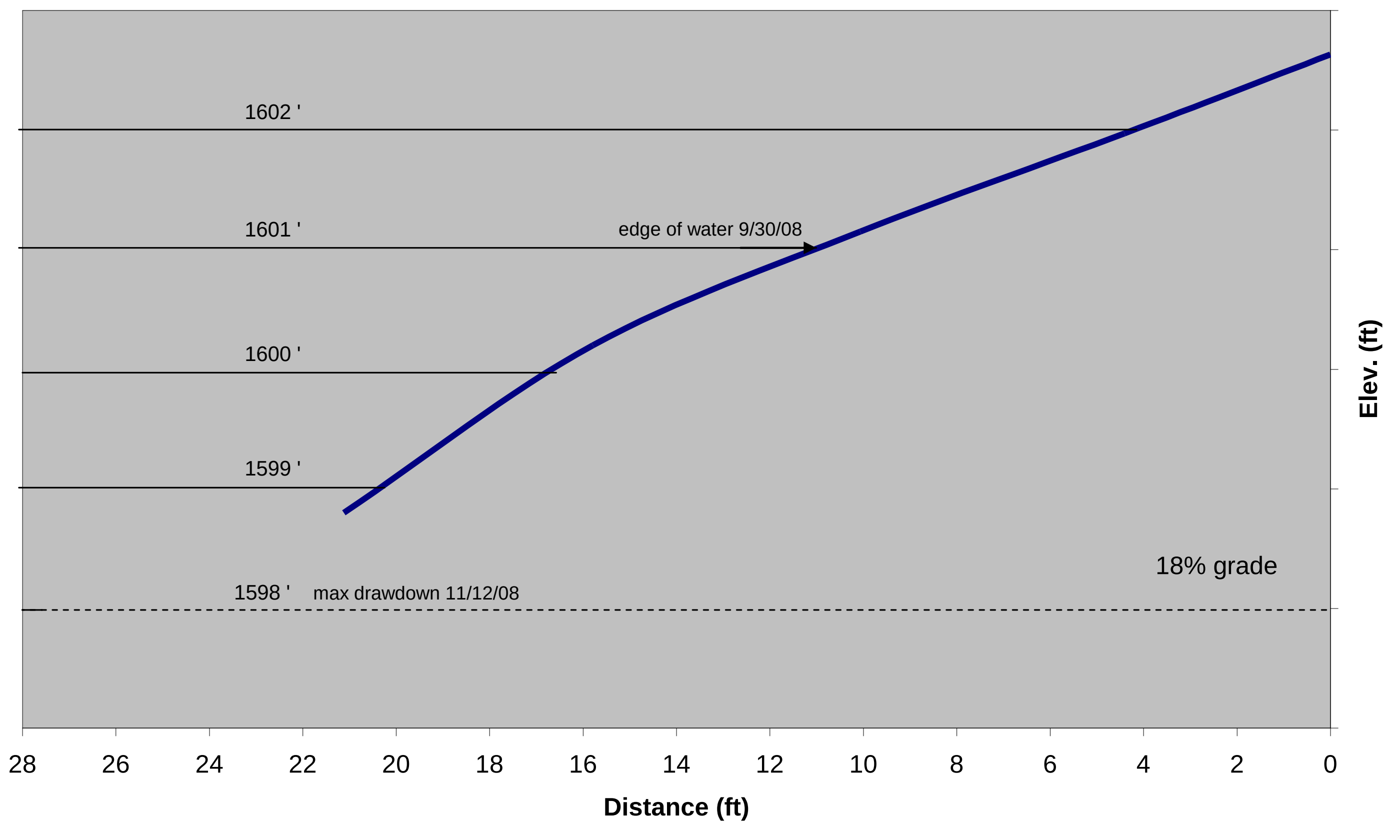


Figure 40. Island Lake Boat Launch Profile

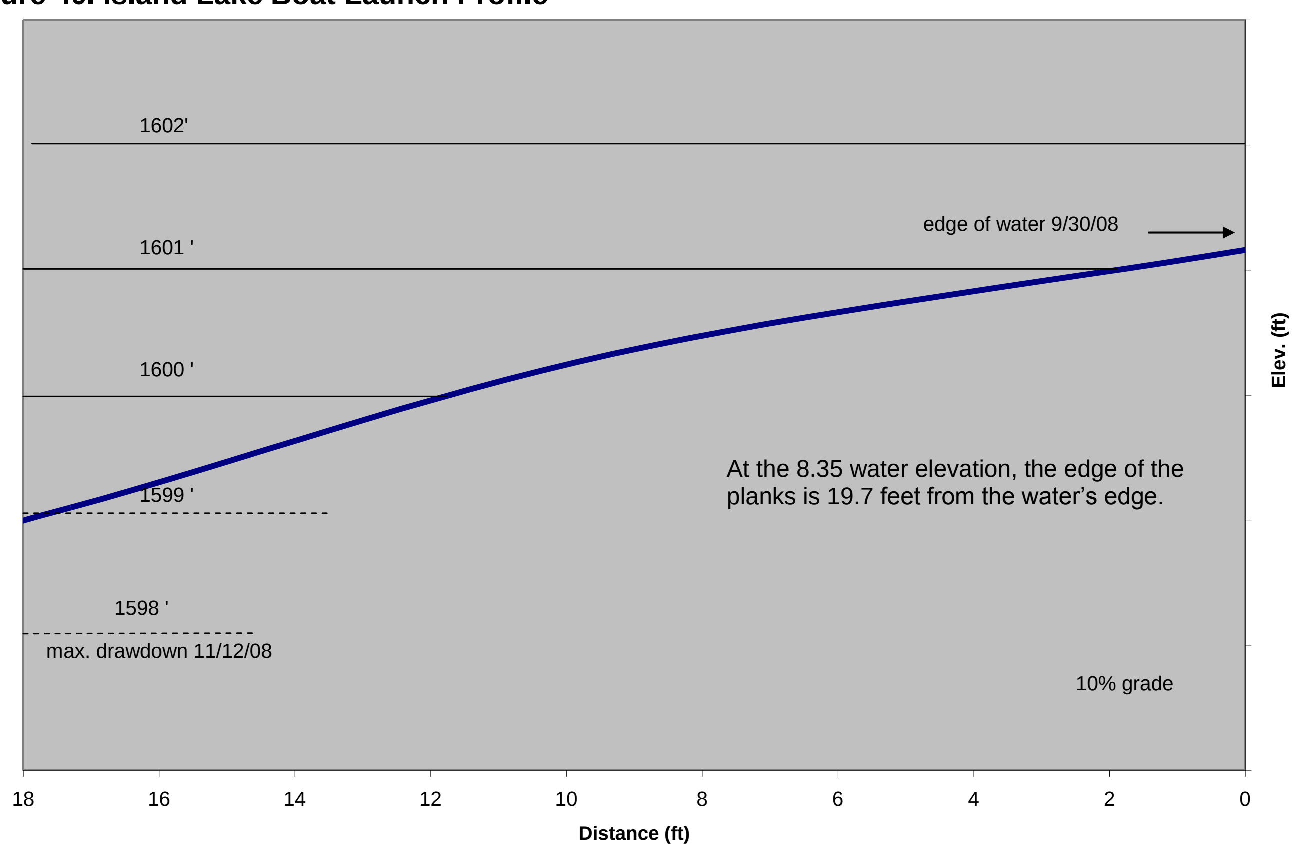
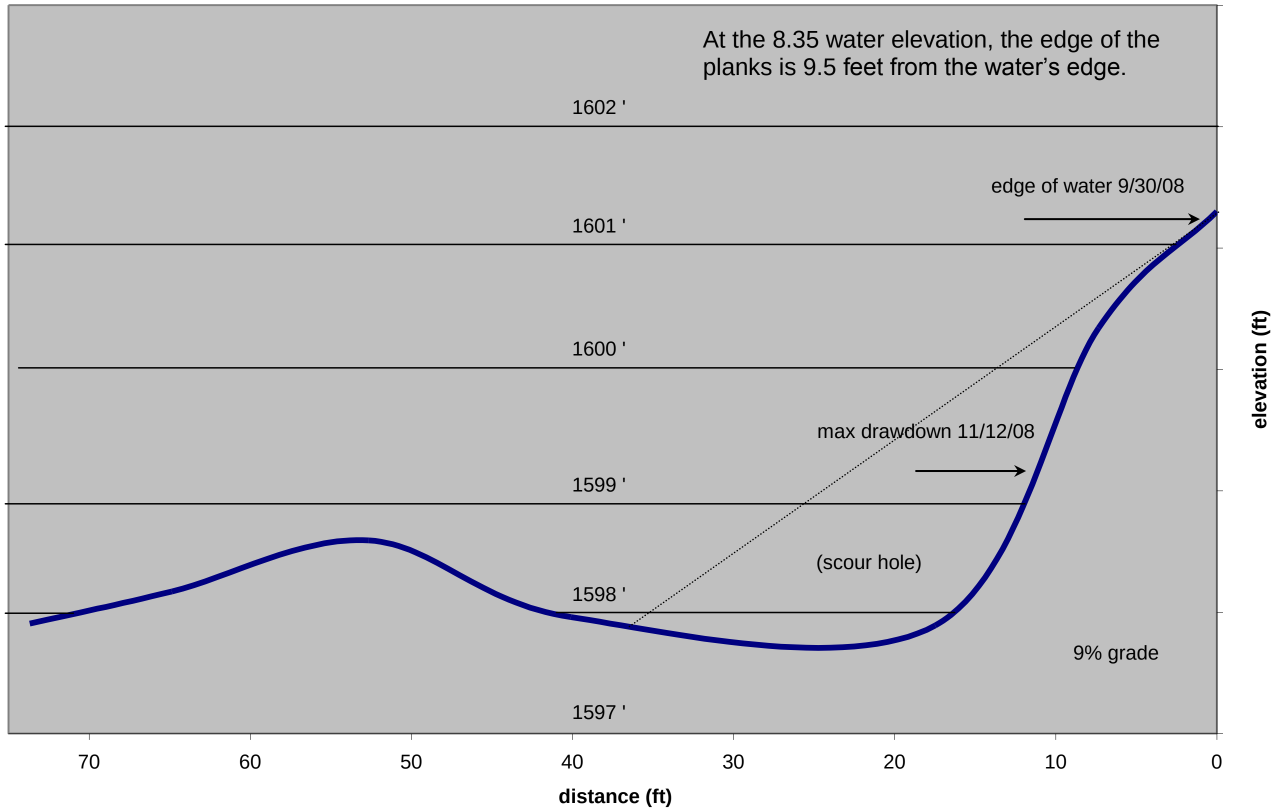


Figure 41. Wild Rice Lake Boat Launch Profile



The 3.5 foot winter drawdown associated with current operations and the 1939 order would continue to create low water conditions on the Chain. The areas that become shallow and difficult to navigate at different water levels can be best evaluated by reviewing the lake contour maps for each lake in the Chain (see appendix III). The majority of the lakes can be navigated at the 7'0" water level but certain areas become more difficult to navigate with larger boats at or below this water level (figure 42). Notable areas include the shallow channel at the Clear Lake Road bridge (between Clear and Fawn Lakes) and Papoose Bay on Rest Lake. Other areas shown on Figure 40 below were also identified by DNR staff on a boat tour of the Chain using a 17.5 foot deep V Sea Nymph Sidewinder with a 90 HP Evinrude outboard at the 7' 0" water level.

Figure 42. Areas on the Chain that are difficult to navigate at the 7'0" water level.

On the river downstream from the dam, navigation becomes difficult in shallow water areas when flows below 80 cfs are passed. With current operations and following the 1939 order, flows below 80 cfs would be passed each spring, often multiple times during the summer, and in some years, the entire summer. Shallow water areas include the rocky area above Sturgeon Lake, the 800 foot long rocky riffle area below the Highway 51 bridge, and the shallow sand bar area below the mouth of Circle Lily Creek. These low flows also increase the travel time between popular river access points like the Highway 51 Bridge, the Highway 51 wayside, and the Highway 47 Bridge.

Alternative III. Public Interest River Flow and Lake Stage

Dam operations based on a public interest flows and lake stages would be a specific schedule of required river stages/flows that restore normative habitat conditions found in Northern Wisconsin lakes and rivers (Table 11). The winter drawdown would be eliminated or reduced in the range of six inches to one foot. If a winter drawdown were specified, the target would be to reach the drawdown level by October 1st and to refill the Chain by April 15th at the latest. Water levels on the Chain would be operated close to 8' 6" but would occasionally need to be lowered in order to meet downstream flow needs. The downstream target flows would be reduced in low water conditions once the lakes reach a specified water level such as 7' 0". Once the Chain reaches that level, the owner of the dam would either need to consult with DNR to determine the required flow or a minimum flow would be specified in the order. Specific ramping rates would also need to be specified as part of the order to avoid quickly changing water levels and flows.

Table 11. Summary of an example public interest flow and stage alternative

Dates	Target Chain Elevation	Target Flows
Winter	Minimum 7'6" or 8'0"	Outflow equals inflow
Late winter or early spring	Fill Chain to 8' 6"	100 cfs or more
Spring thaw flood pulse	Range of 7'0" to 8'6"	200 cfs or more
After the flood pulse to early/mid-summer	Range of 7'0" to 8'6"	150 cfs or more
Summer	Range of 7'0" to 8'6"	100 cfs or more
Late summer and early fall	Range of 7'0" to 8'6"	80 cfs or more
Fall	Range of 7'0" to 8'6" (Any drawdown complete by October 1st.)	100 cfs of more

The target flows identified in this alternative were based on field studies conducted in important types of habitat downstream of the dam. These studies are described in greater detail in the anticipated impacts section below. The USGS hydrological study indicates that it would be feasible to meet the above target flows and Chain elevations the majority of the time if the winter drawdown were reduced or eliminated. The comparison of the target flows and the expected inflows to the Chain can be examined by looking at the flow-duration values for the Manitowish River that were calculated by USGS (Table 12). The designations (FD2 to FD99.6) in the left hand column identify exceedance flows. FD90, for example, means that 90% of the time, flows will be greater than or equal to the flow identified for each month. The target flow values identified in this alternative are close to the FD70 or 70% exceedance flow. Therefore, approximatly70% of the time, the inflow to the dam is expected to be equal to or greater than the target flows. Approximately 30% of the time the Chain elevation would need to be lowered to meet the target flow.

Alternative IV. Passing Inflow

With this alternative, the winter drawdown would be eliminated. A minimum required downstream flow would be specified to address drought conditions. Passing inflows can be defined in different ways. The two variations evaluated in this analysis will be referred to as “passing dam inflow” and “passing gaged inflows”.

If passing dam inflow, the reservoir would be kept very close to the 8’ 6” water elevation and the flow reaching the dam would immediately be passed downstream. Water diversions from cranberry operations and private use would cause downstream flows to drop and would only lower lake water elevations during drought conditions (when pumping and the minimum required flow are greater than the water coming into the Manitowish system). The pumping rate for cranberry operations was estimated at up to 22 cfs and this amount of water can be a substantial portion of downstream river flows during drought conditions (table 12).

If passing gaged inflows, measuring the inflow to the Rest Lake Chain upstream of the cranberry pumping locations would be needed (Figures 5 & 9), and the dam discharge would match the sum of the measured inflows. With this method of passing inflows, water diversions from pumping would result in lowering lake elevations. This would result in a quicker lowering of chain elevations than passing dam inflows but excessive changes to water elevations would not be expected to occur. At a pumping rate of 22 cfs, it would take three months of continuous pumping to result in lowering the chain elevation to the 7’ 6” water elevation.

Table 12. USGS monthly exceedance flows *(from USGS report)*

[FD, flow duration, is followed by a number indicating the percentage of time that the computed value is equaled or exceeded]

Flow duration	Flow-duration value (cubic feet per second)											
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Adjusted drainage-area ratio method											
FD2	246	217	330	568	423	302	267	330	366	328	349	347
FD5	236	208	302	496	354	272	245	251	225	299	308	309
FD10	216	201	265	417	315	246	227	219	207	270	275	280
FD20	180	168	227	330	258	213	203	183	178	222	243	224
FD30	171	157	194	296	236	189	179	166	151	178	218	209
FD40	164	145	177	261	214	176	170	155	133	157	193	197
FD50	148	138	170	231	198	164	157	142	114	140	172	190
FD60	139	133	164	216	168	151	138	107	92.0	118	148	164
FD70	131	125	154	194	154	142	125	91.0	81.8	109	136	145
FD80	125	118	147	179	129	127	96.5	82.6	72.9	103	125	128
FD90	116	111	132	160	112	106	83.9	71.4	64.8	94.2	116	118
FD95	110	108	127	125	94.6	94.5	70.8	63.0	60.2	80.7	110	108
FD98	106	107	122	104	87.3	87.5	64.5	56.4	57.2	71.1	107	105
FD99.6	102	105	106	97.2	81.2	83.3	61.7	51.3	51.6	64.0	96.5	103
	Water-budget method											
FD2	291	291	302	495	488	326	288	305	419	488	357	291
FD5	287	287	290	436	451	306	265	232	344	431	322	287
FD10	275	231	259	394	379	277	232	201	289	345	297	277
FD20	223	213	226	339	313	245	194	163	215	271	260	223
FD30	204	201	215	312	273	213	174	132	184	242	221	208
FD40	195	194	204	291	248	189	148	121	149	213	206	197
FD50	172	168	195	267	226	173	129	106	118	185	193	181
FD60	163	159	179	242	203	155	115	90.6	100	163	184	167
FD70	151	150	164	221	177	137	102	79.7	78.6	138	162	156
FD80	147	134	153	199	149	122	77.3	65.0	61.3	111	144	147
FD90	103	100	132	175	126	95.7	44.4	43.4	44.3	79.9	109	101
FD95	85.7	85.7	113	146	108	70.9	35.2	23.5	29.3	54.8	89.2	85.7
FD98	78.6	78.6	85.7	102	89.7	49.1	28.6	16.0	10.5	14.0	76.6	78.6
FD99.6	78.6	78.6	78.6	88.8	55.9	35.6	13.6	3.6	1.0	-8.3	63.3	78.6

Anticipated Impacts associated with the Public Interest and Passing Inflow Alternatives

Aquatic Habitat on the Chain

By eliminating or reducing the 3.5 foot winter drawdown, both the public interest and passing inflow alternatives would greatly reduce the frequency of low water conditions in the wetlands and shallow water areas on the Chain. This would increase the wetland functionality, habitat availability, and plant and animal diversity in these areas. In many of the shallow wetlands and bays, there would be sufficient water early in the spring which would restore habitat during critical periods for fish and wildlife reproduction needs. Also, during winter, there would be enough water to provide appropriate habitat for furbearers, amphibian and reptile overwintering needs. For example, the impacted shallow water areas depicted in figures 31 and 32 would retain water to some extent over winter, thus providing appropriate overwintering habitat. Additionally, increased organic matter accumulation would likely occur in the near shore zone and over time, a greater density of aquatic plants would likely become established. More vegetation in these areas would provide additional food and cover for a wide range of fish and wildlife species. Impacts to loon nesting would be avoided since water levels would rarely increase during their nesting period. Northern pike populations may increase with more shallow marsh habitat available in the early spring. From a fish management perspective, however, the low pike abundance that is associated with current operations may be a benefit to muskellunge management. A reduced or eliminated drawdown would provide more favorable conditions for a bass, panfish, whitefish, long ear sunfish (state threatened), and numerous minnow species if the plant density increases in the near shore zone. A major change in the type of fishery on the Chain, however, would not be expected to occur.

There are some notable differences between the public interest and passing inflow alternatives. With the public interest alternative, the quantity and quality of available habitat would depend on how much of a fall drawdown is specified and the timing of the refill. Passing dam inflow would keep lake water levels very stable except for drought conditions if minimum required downstream flows were greater than inflows to the Chain and water withdrawals. If gaged inflows were passed, lake water levels would be more quickly lowered by cranberry and other water withdrawals.

Aquatic Habitat Downstream

As river flow below the dam increases, the elevation of the river, or "stage" of the river increases. To determine if sufficient water would be expected with the public interest and passing inflow alternatives, water depths in important types of riparian habitats were measured at various flows.

To quantify wetland habitat water needs downstream of the dam, water level gauges were placed along an 850 foot transect through a wetland floodplain located just upstream from the Highway 47/182 Bridge. The gauges were placed in different types of wetland habitat, and water depth measurements were taken at various flows. The study area encompassed approximately 7.5 acres and is typical of the estimated 1,500+ acre wetland complex in the low gradient section of the Manitowish River. The white star on the aerial photo below shows conditions at 40 cfs and is also the location of on-the-ground photos of the oxbow area under high and low flows shown on figure 43. The numbers below represent sampling points where water level gages were placed.

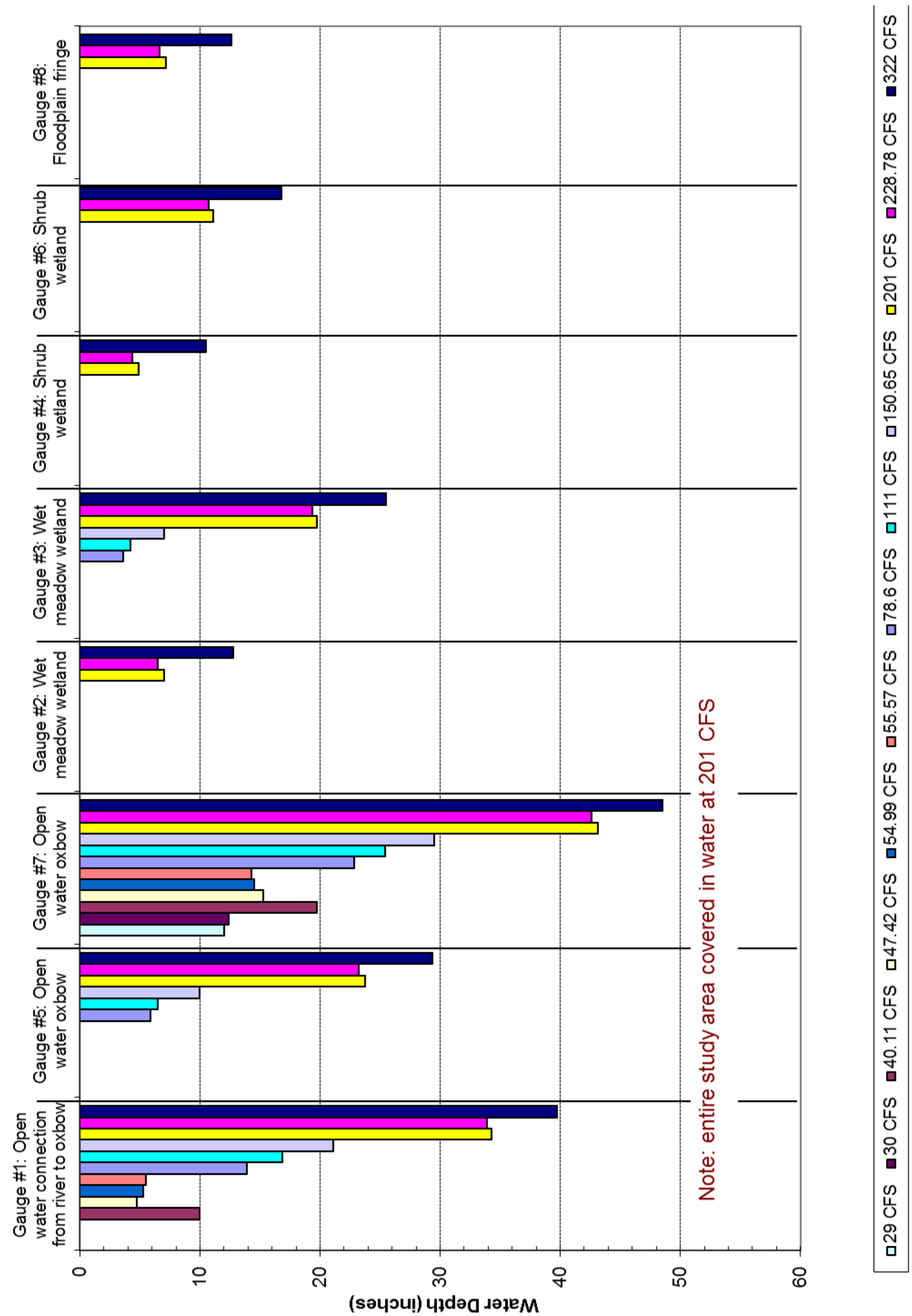
- # 1: open water connection from river channel to oxbow channel
- #2 & 3: wet meadow wetland
- #4 & 6: shrub dominated wetland
- #5 & 7: open water oxbow sloughs
- #8: shrub dominated wetland at the fringe of the floodplain

Through this study, it has been determined that a flow of 200 cfs or higher is needed to flood the entire study area and allow for a natural flood pulse in the associated riparian wetlands. In northern Wisconsin rivers, these high spring flows generally begin in March or early April and slowly subside over time into mid to late June. After this flood pulse, higher elevation wet meadows and shrub dominated wetlands along rivers are no longer flooded, but old oxbows and old river channels remain wetted. Some of the lower elevation old river channels, as seen meandering around the top of the aerial photo on figure 43, will remain connected to the main-stem of the river. During this time, it is important that sufficient water depths and connections remain between the river and these complexes. In order for these areas to remain accessible to a variety of fish and wildlife species for their life cycle needs, flows of 100 or more cfs would be needed through the end of July. Later in the season, a flow of 80 cfs from August to September would still provide some water in these areas but water depths generally slowly recede during this time period as would be expected with a natural flow pattern. The water depths at various flows at the eight locations used in the wetland study are shown on figure 44. The locations with the fewest number of recorded water depths are those that are dry because they are slightly higher in elevation. These areas are the last to flood in spring and the first to drain as flood waters recede.

Figure 43. Wetland transect study area on the Manitowish River.

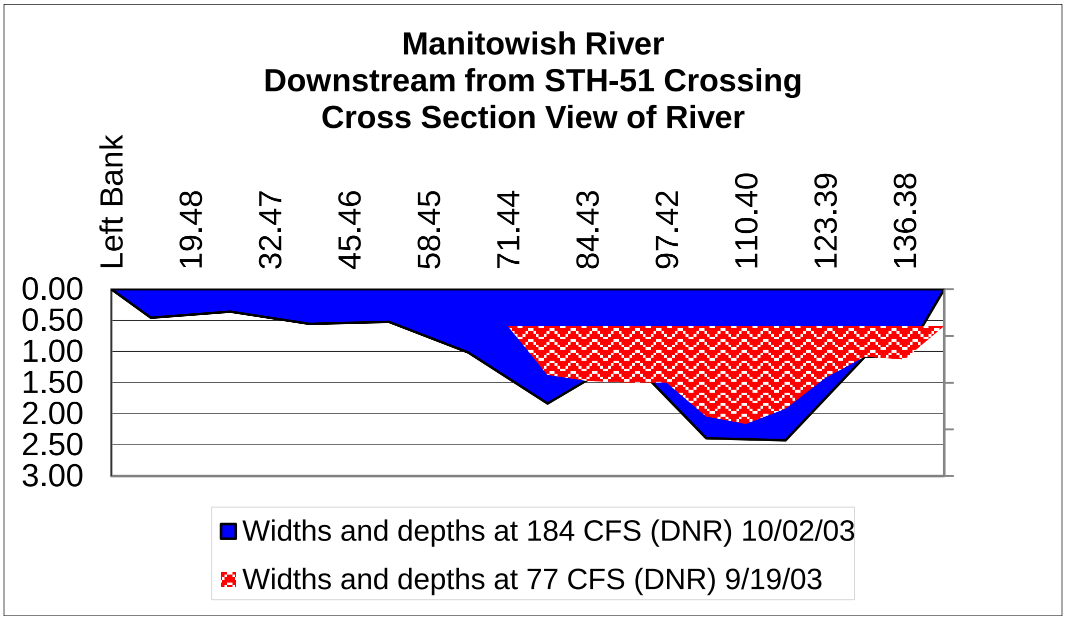
The target flows identified in the public interest alternative would provide sufficient water for the spring wetland flood pulse, and then provide enough surface water in the wetland areas and oxbow channels until mid to late summer. A similar pattern of flows would also be expected with the passing inflows alternative and is evident when looking at flows expected on an average year by looking at the FD50 (i.e. the 50 percent exceedance flow values) identified by USGS on table 12. Consequently, the extent and duration of low water conditions in wetland areas below the dam would be substantially reduced with both alternatives. By avoiding the drought-like river flow conditions that presently occur on an annual basis, more of these areas along the river would have sufficient surface water to be utilized by the fish and wildlife species described earlier in the analysis. Because of this, an increase in the abundance and productivity of fish and wildlife species would be expected. The abundance and productivity of the Pugnose shiner (state threatened) would also be expected to increase since both alternatives would ensure that there is sufficient surface water in shallow wetland areas on the Chain of Lakes and the oxbow and backwater areas downstream of the dam where this species is known to be found.

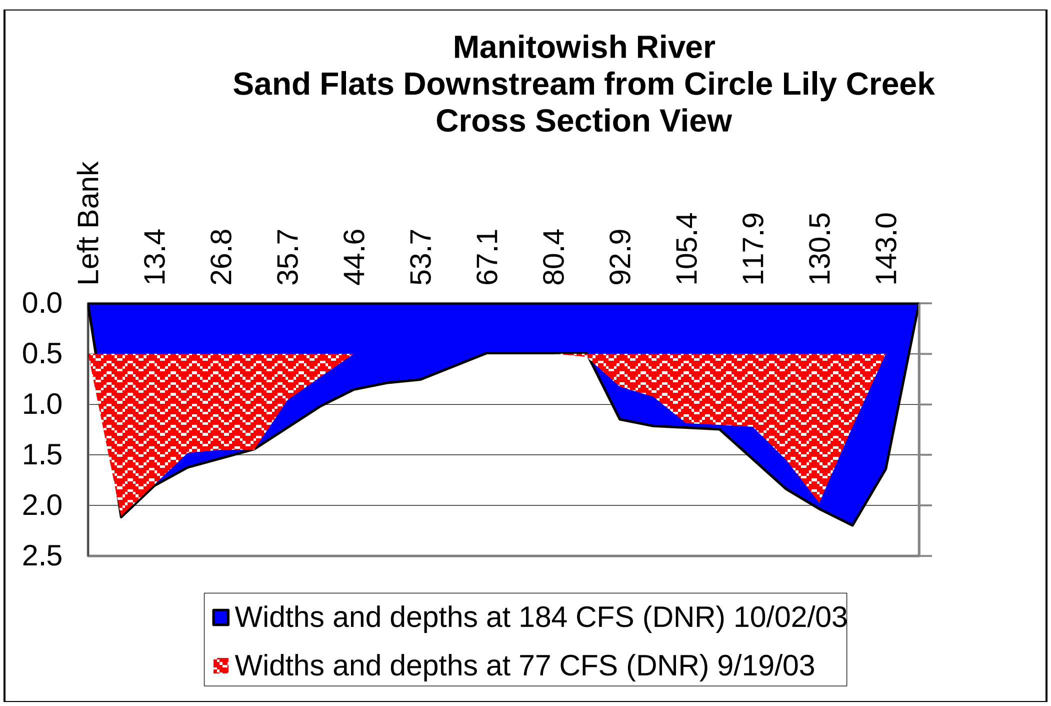
Figure 44. Manitowish River Wetland Study Area Water Depths at Various DNR Measured Flows



River Channel Habitat
Many fish and wildlife species also rely on in-stream channel habitat. The following two graphs are derived from data collected to measure instream conditions at different flows (Figure 45). Even though the two flows shown are not as far apart as natural spring flows (200+ cfs) and current minimum flows (40 cfs), they do represent substantial differences in wetted stream width and depth. These differences are directly correlated to a gain or loss of instream habitat. In areas of the river with shallower bottom contours, the difference in gain or loss is greater than steeper sloped contours. The shallower areas are the first habitats to dewater during reduced downstream flows. The following two graphs show that the entire river channel has at least 6 inches of surface water from bank to bank once flows reach 184 cfs. With a reduced or eliminated winter drawdown, the frequency of low water level conditions in the channel would be substantially reduced and there would be sufficient flows passed in the spring to fully submerge the river channel and to meet fish and wildlife life cycle needs.

Figure 45. Instream Habitat at Different Flows.





Suitable habitat for sturgeon and greater redhorse spawning was identified in the 800 foot section of rocky riffle stretch of the river just below the Highway 51 Bridge. To determine the flow needs for both of these species, a river stage flow relationship was developed by measuring velocities and depths at five transects under various flow scenarios (figure 46). This information was used in habitat suitability models for each species and the following flow needs were developed. For sturgeon, river flows of 125 cfs begin to provide adequate depth in a limited portion of the spawning area. At flows of 200 cfs or more, almost the entire area of potential habitat provides conditions adequate for spawning. Sturgeon spawning generally occurs in late March to the end of May when water temperatures are 53 to 61 degrees. The target flow needed for greater redhorse spawning is 75 to 150 cfs. This species spawns when water temperatures are between 62 and 66 degrees in late May to June. The abundance and productivity of the both lake sturgeon and greater redhorse (state threatened) would be expected to increase with both the public interest and passing inflow alternatives since they are both expected to provide sufficient river flows downstream of the dam during the spawning period for both of these species.

Figure 46. Rocky riffle study area on the Manitowish River below the Highway 51 Bridge. The red lines show the transect locations.

Cultural Resources

With the Public Interest and Passing Inflow alternatives, the influence of the reduced or eliminated winter drawdown on wild rice productivity would be difficult to predict. With a reduced drawdown, water level fluctuations during the critical floating leaf period would be less likely compared to what occurs with the current operation of the dam. This would be expected to help to improve productivity. Alternatively, a reduced drawdown could result in conditions favorable to perennial aquatic plants which would be expected to increase plant competition with wild rice. Since the wild rice stands exist near the inflow-rivers to the Chain of Lakes, and productive rice beds exist on many lake systems that do not have an annual drawdown, reducing or eliminating the winter drawdown is not expected to have a negative impact on wild rice productivity. Continued monitoring would be important to determine if any plant management strategies could be employed to help maintain rice productivity.

Access to the Chain of Lakes for harvesting walleye in the spring would be expected to improve after ice out since a reduced or eliminated winter drawdown would mean higher water levels at boat launches. With reduced annual water level fluctuations, there would be some changes to near shore zone that would be considered both favorable and unfavorable for walleye populations. With higher spring water levels, more gravel spawning areas would be under water. However, if more plants and organic matter established in the near shore zone, conditions in some areas may begin to favor bass and panfish. A substantial change to the walleye fishery would not be anticipated. The Eagle River Chain of Lakes, for example, has a fairly stable year round water level (+/- 0.3 feet) yet these lakes still maintain a good naturally reproducing walleye fishery. Additionally, plant growth on the Eagle Chain is fairly abundant but the bass/panfish population has not become dominant.

As described earlier, both the Public Interest and Passing Inflow alternatives would be expected to provide 200 or more cfs in May and June when lake sturgeon spawn in the rock riffle area. With sufficient flows during this time, natural reproduction would be expected to increase. Over time, it is likely that more age classes of fish would be documented.

Ice action on the shorelines caused by wind pushing ice sheets would be expected to increase with a reduced or eliminated winter drawdown. This would potentially have an impact on archaeological sites but excessive damage would not be expected since most of the lakes on the Manitowish Chain have a fetch of one mile or less and would be considered low energy shorelines. A reduced drawdown, however, would be expected to allow more aquatic plants to establish in the near shore littoral zone which would be a benefit to shoreline protection from erosion caused by wave action. As stated earlier, before a new operating order would be drafted or issued, staff would need to coordinate with archaeologists in the Department and in the Lac du Flambeau to review the location of known sites and determine if any protective measures would be needed.

Social and Economic Environment

The public interest and passing inflow alternatives would not be expected to negatively impact property values since the maximum water level would remain the same and there would not be a change to the ordinary high water mark or additional lands flooded. One potential impact to property would be the increased possibility of ice action to cause damage to permanent piers, wet boat houses, and other structures. Based on the survey of structures on the Chain, it appears that many permanent structures would be wet with either a one foot drawdown or with no winter drawdown. The potential for impacts would be similar to the conditions that occur on the majority of lakes in Wisconsin, including natural lakes and impoundments. Also, excessive damage would not be expected since the shorelines on the Chain are considered “low energy” shorelines for ice action due to the relatively small sizes of the lakes and limited fetch for wind to push the ice sheet. To reduce or eliminate the potential impact of ice, more landowners would likely remove their piers at the end of the summer. For structures that cannot be moved, aeration systems and other methods to minimize ice damage would need to be installed by landowners. These methods are commonly employed on thousands of other lakes and impoundments that have a minimal winter drawdown or no drawdown. Other lake chains in Northern Wisconsin, for example, also have numerous permanent structures at or below the ordinary high water mark such as the Eagle River Chain and the Minocqua Chain of Lakes. The Eagle River Chain is usually operated with only a 0.3 foot water level difference year round. The Minocqua Chain has a 1.05 foot difference between summer and winter water levels during years with low precipitation and minimal snow pack. Also, the refill of the Minocqua lakes often begins with the initial spring runoff while there is still ice on the lakes which has generally been in March but has been as early as the third week in February.

Along the shorelines of the Manitowish Chain, reduced dewatering of the current 3.5 foot drawdown zone would likely result in a higher density of aquatic plants becoming established closer to the shoreline. If this would occur, in addition to providing habitat to fish and other aquatic organisms, the vegetation would help to stabilize shorelines against wave erosion.

With reduced low water conditions upstream and downstream of the dam, lake access at boat launches, navigation on the Chain of Lakes, and navigation downstream of the dam on the river would substantially improve. Above the dam, target water levels would be operated at or near the 8' 6" elevation and downstream flows above 80 cfs would be expected the majority of the time. There would likely be an increase in the time people spend traveling to and using these resources and this would be expected to have a positive impact on the money spent at area businesses.

Since the current operation was found by the FERC analysis to be insignificant to augment downstream energy production, reducing the winter drawdown would be expected to have little to no impact on Xcel's hydropower production. In terms of operating the dam, passing dam inflows would be considered the simplest operationally for the dam tender. With the Public Interest alternative, the multiple target levels and flows would make dam operation more complicated but would still be feasible. Similarly, passing gaged inflows would be more involved for the dam tender and the operating order would need to specify a schedule of equalizing dam discharge based on inflow measurements. With this alternative, there would also be operational costs associated with keeping inflow gaging stations operating and making sure inflow recordings are accurate.

Higher water levels on the Chain would make pumping easier for cranberry operations. Under an operating order passing the gaged inflows, the water used for these operations would only be taken from the reservoir and would occasionally result in lowering the water elevations on the lakes. Excessive lake level changes and impacts to upstream resources or navigation would not be expected to occur. As described earlier in the analysis, it takes about 70 cfs to fill the Chain one foot in one month. Therefore, when considering a cranberry pumping rate of about 35 cfs, pumping would need to occur continuously for two months to drop water levels to the 7' 6" water level. This would only be expected to occur in severe drought conditions similar to what occurred in 2007. Alternatively, with the passing dam inflow operations, the water diverted from cranberry operation would only be taken from downstream flows. With this method of passing inflows, taking 35 cfs from downstream flows can have substantial negative impacts on downstream resources, especially during low precipitation periods.

Impacts to Special Resources

A reduced or eliminated winter drawdown would make it possible to restore a more natural pattern of water flows and levels to the Manitowish River system upstream and downstream of the dam. Because of this, the overall habitat quality and function would be expected to improve. This would improve the overall environmental quality of the State Natural Areas and other designations that have been identified for the Manitowish River system.

15. Environmental Effects and Their Significance

a. Discuss which of the primary and secondary environmental effects listed in the environmental consequences section are long-term or short-term.

The duration and extent of effects would last as long as the dam is operated in a way that would create a natural pattern of water levels and flows in lake and river systems. Certain impacts, such as changes to wetland plant communities downstream of the dam, the bioavailability of mercury in the aquatic food Chain, or the reestablishment of plants in the near shore littoral zone in the lakes upstream of the dam, could take a number of years to take effect. Fish and wildlife species would quickly begin to utilize the near shore and wetland habitat on the Chain as well as the rocky riffle river channel, the wetlands, oxbows, and backwater areas below the dam. The social economic impacts, including improved recreation and navigation, the installation of methods to avoid potential damage to piers and structures, and other impacts described in the analysis would also be considered short term effects that would occur within months of the implementation of a new operating order.

b. Discuss which of the primary and secondary environmental effects listed in the environmental consequences section are effects on geographically scarce resources (e.g. historic or cultural resources, scenic and recreational resources, prime agricultural lands, threatened or endangered resources or ecologically sensitive areas).

The restoration of a natural flow pattern below the dam and reducing the occurrence of low water conditions above the dam would reduce the current negative impacts to waterway and wetland habitat utilized by number of different scarce resources such as the greater redhorse, wood turtle, long ear sunfish, and the pugnose shiner. Impacts to culturally important resources such as wild rice and lake sturgeon would also be avoided and minimized by reducing water level fluctuations during the floating leaf stage of rice and providing for adequate river flows for the spawning of lake sturgeon.

c. Discuss the extent to which the primary and secondary environmental effects listed in the environmental consequences section are reversible.

The primary and secondary environmental effects would be largely reversible since they are directly tied to the operation of the dam and the way water levels and flows are managed.

16. Significance of Cumulative Effects

Discuss the significance of reasonably anticipated cumulative effects on the environment (and energy usage, if applicable). Consider cumulative effects from repeated projects of the same type. Would the cumulative effects be more severe or substantially change the quality of the environment? Include other activities planned or proposed in the area that would compound effects on the environment.

The proposal is unique to the project area and is not tied to other Department activities planned in the area or statewide. One aspect of the proposal, improving the conditions for lake sturgeon reproduction on the Manitowish River, is identified in the statewide sturgeon management plan. If all dams were operated according to the alternatives outlined in this analysis, it would be anticipated to have an impact on hydropower generation and flood control in Wisconsin. The proposal to change the operation of the Rest Lake Dam and the range of alternatives considered is closely tied to the recognized purpose and need of this particular dam and the impacts it has on the Manitowish Chain of Lakes and the Manitowish River system. The current proposal is site specific and not tied to proposals to issue new operating orders at other dams in Wisconsin.

17. Significance of Risk

a. Explain the significance of any unknowns that create substantial uncertainty in predicting effects on the quality of the environment. What additional studies or analysis would eliminate or reduce these unknowns?

The growth and productivity of wild rice is complex and difficult to fully predict because each lake is unique and productivity is based on a number of site specific factors. Because of this complexity, there are no additional studies or analysis that would eliminate or reduce the uncertainty associated with a potential change in the operation of the dam. If a new operating order were issued, it would be important to continue to monitor wild rice productivity on the Chain. If changes started to occur, adaptive management strategies could be considered to support good conditions for the productivity of wild rice.

b. Explain the environmental significance of reasonably anticipated operating problems such as malfunctions, spills, fires or other hazards (particularly those relating to health or safety). Consider reasonable detection and emergency response, and discuss the potential for these hazards.

There are no known operational or dam failure hazards associated with the range of alternatives considered in this analysis.

18. Significance of Precedent

Would a decision on this proposal influence future decisions or foreclose options that may additionally affect the quality of the environment? Describe any conflicts the proposal has with plans or policy of local, state or federal agencies. Explain the significance of each.

The proposal to write a new operating order for the dam is not expected to influence future decisions or foreclose options that may additionally affect the quality of the environment. Each project needs to be evaluated on a case-by-case basis. There are no known conflicts between the Department's proposal and plans or policy of local, state, or federal agencies.

19. Significance of Controversy Over Environmental Effects

Discuss the effects on the quality of the environment, including socio-economic effects, that are (or are likely to be) highly controversial, and summarize the controversy.

The proposal to write a new operating order for the dam has been locally controversial. Many people that own property on the Chain of Lakes have expressed concern over a change to the lake water levels that they are used to. There is also concern with the potential damage that ice may cause if the extent of the winter drawdown is reduced or eliminated and a perception that a change in the operation of the dam would reduce property values. Downstream, there has been concern that the impacts with the current operation of the dam would not be addressed to reduce property damage, improve navigation, and reduce the occurrence of low water conditions on the river especially during the spring and early summer months.

20. List agencies, citizen groups and individuals contacted regarding the project (include DNR personnel and title) and summarize public contacts, completed or proposed).

Date	Contact	Comment Summary
2002 - 2006	Rest Lake DNR Workgroup Meetings	Periodic meetings were held to discuss issues related to the operation of the Rest Lake Dam. Members included representatives from the DNR, Town of Manitowish Waters, Manitowish Waters Lakes Association, Manitowish Waters Alliance, and Friends of the Manitowish River.
Oct 25 2006	Voigt Task Force (VTF)	Opportunity for formal consultation and asked for comments on potential wild rice impacts.
2007 - 2012	Local stakeholders	DNR administrative staff had numerous informal meetings with local stakeholders regarding concerns with the operation of the Rest Lake Dam.
Aug 25 2007	Public Input Meeting	A public meeting was held at the Manitowish Waters Town Hall from 2:00 to 6:00 p.m. to allow the public to identify issues that should be evaluated in the environmental analysis.
Aug 12 2008	Lac du Flambeau Tribe	Meeting to discuss tribal interest issues that should be evaluated in the environmental analysis.
Nov 3 2008	Great Lakes Indian Fish and Wildlife Commission (GLIFWC)	Opportunity for formal consultation and feedback regarding issues to consider in the environmental analysis.
Nov 12 2008	Vilas Cranberry Company	Met with cranberry producers to discuss water withdrawals from the Trout River to Little Trout Lake
Apr 15 2011	Lac du Flambeau Tribe	Preliminary draft of the environmental overview document provided to a representative from the Lac du Flambeau Tribe for review and comment.
Jun 17 2011	Environmental Overview Document	Posted on the DNR website and copies provided on request.
Jul 20 2012	Voigt Task Force and Great Lakes Indian Fish and Wildlife Commission request for consultation	Opportunity for formal consultation and a preliminary draft of the environmental analysis provided to a representative from the Lac du Flambeau Tribe and GLIFWC.

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ATTACHMENTS

Appendix I. Copy of the 1937/1939 Rest Lake Dam operating order.

Appendix II. USGS report: "Estimation of Natural Historical Flows for the Manitowish River near Manitowish Waters, Wisconsin"

Appendix III. Lake contour maps for Alder, Clear, Fawn, Island, Little Star, Manitowish, Rest, Spider, Stone, and Wild Rice Lakes.